

Dr. Dick was evidently actuated by an intense desire to learn, at first hand, through purely empirical methods. That little observatory atop his dwelling at "Broughty Ferry, near Dundee," with its old-fashioned instruments and appliances, has, it must be confessed, long been an inspiration to the writer in these and other astronomical pursuits, and it is a pleasant memory how highly my dear old friend, "Uncle John" Brashear, spoke of the work accomplished there, himself an exemplar of enthusiasm and experimental philosophy. The remarks to be found here and there in Dr. Dick's engaging chapters were often forward-looking, and it might be truthfully conjectured that if he were living in the present age of astronomical progress he would be foremost among observers of the heavens.

TREDYFFRIN OBSERVATORY, BERWYN, PENNSYLVANIA, OCTOBER, 1945.

The Names of the Satellites

By SAMUEL G. BARTON

I have recently investigated the sources of the names of the satellites and the search leads me to believe that it will be of interest to others to have the scattered material collected. Some of it is in rather inaccessible places. I have no knowledge that this has ever been done. The material is arranged in order of increasing distances of the planets from the Sun, although from some points of view the order of discovery would be more logical.

The Moon is unique in that, at least until the time of Copernicus, it, like the Sun, was regarded generally as a planet. No satellites, as such, were known. Our name, the Moon, comes to us through the Anglo-Saxon. In this it is like the name, the Sun, but not like those of the planets, which, excepting the Earth, come from Roman mythology.

The satellites of Mars were discovered by Asaph Hall, at Washington, D. C., in 1877. By right of discovery, he named them. The story as told by him,¹ is:

"Of the various names that have been proposed for these satellites, I have chosen those suggested by Mr. Madan of Eton, England, viz:

DEIMOS for the outer satellite;

PHOBOS for the inner satellite.

"These are generally the names of the horses that drew the chariot of Mars; but in the lines referred to they are personified by Homer, and mean the attendants, or sons of Mars. These lines occur in the Fifteenth Book of the Iliad, where Ares is preparing to descend to the earth to avenge the death of his son. Bryant's translation is as follows:

He spake, and summoned Fear and Flight to yoke
His steeds, and put his glorious armor on."

These lines explain why the names are cited in some places as those of horses and in others as those of gods. Liddell and Scott's Greek Lexicon explains that in Homer, phobos means flight, properly, the outward show of fear, as opposed to deos (poetic deimos), the sensation of fear.

The existence of satellites of Jupiter was first made known with the announcement of the discovery of four, by Galileo, in 1610. To distinguish them from the far fainter satellites since discovered, these four are known as the Galilean satellites. This title, a most natural one, was probably first applied by W. T. Lynn.² After a discussion of memorials and of the transitory character of human monuments, Galileo, in the introduction to his "*Sidereus Nuncius*," writes:³

"Wherefore the fame of Jupiter, Mars, Mercury, Hercules, and the rest of the heroes by whose names stars are called, will not fade until the extinction of the splendour of the constellations themselves . . .

"And so, inasmuch as under your patronage, most Serene Cosmo, I have discovered these stars, which were unknown to all astronomers before me, I have, with very good right determined to designate them with the august name of your family, and as I was the first to investigate them, who can rightly blame me if I give them a name, and call them the Medicean Stars (*Medicea Sidera*), hoping that as much consideration may accrue to these stars from this title as other stars have brought to other heroes."

The reference is to the "Most Serene Cosmo de' Medici, the second, fourth Grand Duke of Tuscany," who was Galileo's pupil and patron. The memorial has not proven as enduring as Galileo supposed, for, as Bailly comments:⁴ "This glorification was not flattery, but only a recognition of a great city, long governed by a beneficent family. The name Medici was already dear to the arts; but the honors most merited are not those most durable. Passing from the hands of Galileo the theory of these stars was cultivated in France and in England, where this name had not the same claim. These planets belong more to Jupiter than to princes of the Earth and they keep the name of his satellites."

But Galileo was not alone in discovering these satellites. Simon Marius, court astronomer of the margraves of Brandenburg, in his work, "*Mundus Jovialis*" (the world of Jupiter), published in 1614, claims to have discovered them even earlier than Galileo. With the idea of honoring his patrons, similar to that of Galileo, he called the satellites, the Brandenburgian stars (*Sidera Brandenburgica*).

An extract from a letter, which Galileo received on this occasion from the court of France, will serve to show how highly the honor of giving a name to these new planets was at that time appreciated, and also how much was expected from Galileo's first success in examining the heavens:⁵ "The second request, but the most pressing one which I can make to you, is, that you should determine, if you discover any other

fine star, to call it by the name of the great star of France, as well as the most brilliant of all the Earth; and if it seems fit to you, call it rather by his proper name of Henri, than by the family name of Bourbon; thus you will have an opportunity of doing a thing just and due and proper in itself, and at the same time will render yourself and your family rich and powerful forever." The writer then proceeds to enumerate the different claims of Henri IV to this honor, not forgetting that he married into the family of the Medici, etc.

In order to have individual names for the satellites, Marius suggests that they be called Mercurius Jovialis, Venus Jovialis, Jupiter Jovialis, and Saturnus Jovialis, that is, Mercury of Jupiter corresponding to Mercurius Solaris, Mercury of the Sun, etc. Saturnus Jovialis, the outermost satellite would then correspond with Saturn, the outermost planet then known. Mars, he explains, is excluded because of its exceptional color and because the influences attributed to it by astrologers are the opposite of those attributed to Jupiter, which would render its presence inharmonious. No mention is made of the Earth.

Following this discussion Marius continues with words which I quote in the original Latin, as well as in translation, since the original is quite difficult of access. I have used the copy bequeathed to the Franklin Institute by Dr. Gustavus W. Cook.

"Forsitan autem non deerunt, quibus hactenus recensita nomina non placebunt, sed proprium uniuscui usque horum quatuor Jovialium siderum nomen ab Astronomis flagitabunt. Ijs etiam in hunc modum satisfieri posse puto, quod tamen absque ulla superstitione & cum licentia Theologorum factum volo. Jupiter à poëtis ob illicitos maximè amores arguitur: Inprimis autem celebrantur maximè tres foeminae Virgines, quarum furtive amore Jupiter captus & potitus est, videlicet Io Inachi Amnis filia: Deinde Calisto Lycaonis, & denique Europa Agenoris filia: Quin etiam impensius amavit Ganymedem puerum formosum, Trois Regis filium, adeo etiam ut assumptâ aquilâ figurâ, illum humeris impositum, in coelum transportavit, prout fabulantur poetae, inprimis autem Ovidius lib. 10 fab. 6. Itaque non male fecisse videor, si Primus à me vocatur Io Secundus Europa: Tertius ob luminis Majestatem Ganymedes Quartus denique Calisto. Quae nomina sequenti disticho comprehenduntur.

*Io, Europa, Ganymedes puer, atque Calisto,
Lascivo nimium perplacere Jovi.*

"Huic figmento & priorum nominum impositioni occasionem prae-buit Dominus Keplerus Caesareus Mathematicus, quando mense octobri Anni 1613, Ratisbonae in Comitibus unâ eramus. Quare si per jocum & per amicitiam inter nos tunc initum, illum compatrem horum quatuor siderum salutavero, haud male fecero.

"Verum uti haec nomina omnia à me sunt liberè conficta, ita etiam cuique liberum esto, ea vel repudiare vel acceptare."

This passage may be translated as follows:⁶ "Perhaps, however, there will be some who will not be satisfied with the names hitherto applied, but will demand from astronomers a name for these four satellites of Jupiter that will be appropriate to each and every one of them. I think that these persons can actually be satisfied in this respect; however I want the thing done without any superstition and with the sanction of theologians. Jupiter especially is charged by the poets with illicit loves. Especially well known among these are three virgins, whose love Jupiter secretly coveted and obtained, namely: Io, the daughter of the river god Inachus, then Callisto daughter of Lycaon, and finally Europa, the daughter of Agenor. Yet even more ardently did he love the beautiful boy Ganymede, son of the king of Troy, to the extent that, having assumed the form of an eagle, he placed him on his shoulders and transported him to heaven (Olympus) according to the tale told by the poets, especially by Ovid in book 10 fable 6 (of the *Metamorphoses*). And so I believe I have not done badly in naming the first Io, the second Europa, the third, on account of the splendor of its light, Ganymede, and lastly the fourth Callisto. These names are comprised in the following distich:

Io, Europa, the boy Ganymede, and likewise Callisto
aroused to excess the lust of Jove.

"Mr. Kepler, the Imperial Mathematician, presented the opportunity for this fanciful application of names when we were together at a meeting in Ratisbon (Regensburg), in October, 1613. Therefore, if I hail him as the co-sponsor of these four stars as a result of a jocular fantasy and of the friendship begun between us at that time, I shall not have done badly.

"But all of these names have been freely imagined by me, so let everyone feel free either to reject or to accept them."

The article on Ganymede in the "Encyclopaedia Britannica" may well be read in this connection.

In 1623 Galileo⁷ denounced the claims of Marius to discovery, accused him of plagiarism, etc. Marius was then suffering from the illness of which he died and was unable to defend himself. His reputation suffered severely from these unjust allegations, widely believed, but in recent years he has had able defenders, notably Oudemans and Bosscha,⁸ and there seems little reason to doubt his integrity and ability, or to doubt that he discovered the satellites independently, either earlier than Galileo or at practically the same time.

This controversy had much influence in the naming of Jupiter's satellites. Those who favored Galileo and who thought Marius an imposter declined to use the latter's names lest their use be regarded as a recognition of his claims, and others thought it might at least give him a preference. So to this day the names Io, etc., are little used. No names of this type are used in the *American Ephemeris*. The *British Nautical*

Almanac makes a little use of them.

Galileo, beginning about January, 1611, designated the satellites individually by the numbers one to four (really one to four dots) in order of increasing distance from the planet. This is an impersonal system. Really, because of the many phenomena, occurring with the four bright satellites and needing description (eclipses, occultations, and transits), no other system can compare in simplicity with that of numbering and this has probably been a factor in naming them.

In 1892, after the number system had been in use for centuries, a fifth satellite of Jupiter was discovered by Barnard at the Lick Observatory. In September, 1893, he wrote as to its name:⁹ "So far this satellite has not received any name, although many names have been suggested for it. Most of these are mythological and have some connection with Jupiter. Columbia, on account of the satellite being found in the Columbian year, and Eureka, because of California, the state in which it was discovered, have been suggested. It would seem, however, almost to have found itself a name—'The Fifth Satellite.'

"In astronomical literature there is a strong tendency to call it simply 'The Fifth Satellite' as it was called in the announcement of discovery. There is some opposition to this, as it might be misleading. The other satellites of the giant planet, besides their mythological names, are also designated as I, II, III, IV, with the Roman numerals, in the order of their distance from Jupiter. If now the new one is called V it would imply that it is the most distant of the satellites, while in reality it is the nearest of all to the planet, and ought by all means, according to this method of numeration, to be Satellite I, which would necessitate a re-numbering of the satellite system. I would say, also, in this connection, that the celebrated French astronomer, Camille Flammarion, has written, suggesting the name Almathea, the nurse of Jupiter (the smallness of the satellite would make this name rather inappropriate), and giving various reasons why it should be so called.

"The most that can be said at present is that it is yet nameless, and may so remain. The mythological names of the four older satellites are seldom used. It may be necessary, however, to give it a mythological name to prevent confusion."

In July, 1894, he wrote:¹⁰ "The numerals, to me at least, stand as names, and do not necessarily have any bearing on the relative distances of the satellites. It would be dangerous and absurd to change the present notation to introduce the new satellite as I, and it would be equally absurd to call it O, as some have suggested, for we cannot tell what development the great telescopes of the future may bring about in the Jovian satellite-system.

"I think, therefore, that this new moon should continue to be called the 'Fifth Satellite,' or Satellite V, as I have always called it. This will also be correct if we assume the other satellites were numbered in the

order of their discovery, which can be done without violating the facts.

"There is certainly nothing to be gained by giving this object a special mythological name. However, if it is the general desire of astronomers that it should bear such a name, I will select one for it.

"The other satellites of the solar system (except that of Neptune) are suitably named and those names have come into regular use. Why not let the magnificent Jovian system differ from all the rest by a different order of nomenclature."

The year 1892 is called the Columbian year because it marked the 400th anniversary of the discovery of America by Columbus. Eureka, the exclamation of Archimedes, is the motto of the State of California, found on its great seal. W. T. Lynn¹¹ suggested for the satellite the name Fulmen, the Latin word for thunderbolt, or Keraunos, the Greek equivalent, and discussed names in general. Other names of the nature of those used by Marius come to mind, such as, Dione, Leda, Leto or Latona, Maia, Metis, Mnemosyne, and Semele, all of which, however, have been used as names of asteroids, but then so have Io, Europa, Ganymed, and Kallisto and I think no confusion has been thus created. Dione is also the name of a satellite of Saturn. Almathea is likewise the name of an asteroid. What, indeed, isn't?

The fifth satellite remains otherwise nameless. Barnard's caution as to possible future discoveries has been justified by the discovery of six additional satellites. These are also nameless except as they are known by the numbers VI to XI, applied in the order of discovery. The satellites in the order of increasing distance from Jupiter are V, I, II, III, IV, VI, VII, X, VIII, IX, XI. This list gives additional evidence of the instability of a system of numbering according to distance. Furthermore the distances of satellites VI, VII, and X are nearly equal as is also the case with VIII, IX, and XI. A slight change in the distance of any of these satellites (and the perturbations are large, particularly in the outer group)¹² might change the order of relative distances. In the case of Jupiter precedent has probably deterred discoverers from assigning names to the more recently discovered satellites.

The situation with respect to the satellites of Saturn was somewhat comparable. Huygens discovered the brightest satellite, now known as Titan, in 1655. He called it simply, Luna Saturni, the moon of Saturn. In the dedication to his "Systema Saturnium," written in 1659, he wrote concerning it:¹³ "We should rejoice in its capture, for, hitherto lacking one, it now completes the collection of wandering stars and their number twelve. I almost venture to assert that in the future no more will be found. What is certain is that the small planets exist from this time in number equal to that of the large and primary planets, among which must be counted this Earth, and that the two groups together are expressed by the number which we consider as perfect, on the strength of which we could believe that this mode of existence has been pre-

destined by the Supreme Architect."

These remarks were soon rendered absurd by the discovery of a second satellite in 1671, a third in 1672, a fourth and a fifth in 1684, all by G. D. Cassini, who wrote:¹⁴ "The satellites of Saturn, still more grand and more difficult to discover (than the *Sydera Medicea* of Galileo), are not unworthy of bearing the name of Louis le Grand (Louis XIV), since they have been discovered under the glorious reign of his majesty and because of the extraordinary assistance furnished to astronomers at his observatory at Paris. We may justly call them the Louisian Stars (*Sydera Lodoicea*)."

This name I understand to include the five known satellites. Proctor,¹⁵ however, restricts it to the four discovered by Cassini. Titan was discovered in Holland, but during the king's reign, and its discoverer, Huygens, enjoyed the king's patronage from 1661 to 1681, living then in Paris.

In order to distinguish the satellites from each other, Cassini denominated them according to their distances from the planet, the innermost being the first satellite. According to this nomenclature, the satellite discovered by Huygens, although first in order of discovery, was designated the fourth satellite.

A sixth and a seventh satellite were discovered by Sir Wm. Herschel in 1789, both closer to the planet than the other five. He designated them as sixth and seventh in order of discovery, the seventh being the closer to the planet. The situation was then a confused one.

This is the story as told by Sir John Herschel:¹⁶ "Considerable confusion used already to prevail before the discovery of this satellite (the eighth), in the nomenclature of the saturnian system owing to the order of discovery not coinciding with that of distances. Astronomers were not agreed whether to call the two interior satellites the sixth and seventh (reckoning inward) and the older ones the 1st, 2d, 3d, 4th, and 5th, reckoning outward; or to commence with the innermost and to reckon outward, from 1 to 7. This confusion, which the introduction of an eighth would have reckoned intolerable, has been obviated by a mythological nomenclature, suggested in a former edition of this work, and which has been generally accepted, in consonance with that at length completely established for the primary planets. Taking the names of the Titanian divinities, the following verses (pardoning false quantities) afford an easy artificial memory.

*Japetus cunctos supra rotat, huncce sequuntur
Hyperion, Titan, Rhêa, Dionê, Têthys,
Enceladus, Mimas—*

"It is worth remarking that Simon Marius, who disputed the priority of the discovery of Jupiter's satellites with Galileo, proposed for them mythological names, *viz.*, Io, Europa, Ganymede, and Callisto. The revival of these names would savor of a preference of Marius's claim,

which, even if an absolute priority were conceded (which it is not), would still leave Galileo's general claim to the use of the telescope as a means of astronomical discovery intact. But in the case of Jupiter's satellites there exists no confusion to rectify. They are constantly referred to by their numerical designations in every almanac."

This rather lengthy passage merits quotation in full. It requires considerable comment. The translation of the verse is, Japetus revolves outside all the others and this is followed by Hyperion, etc. The pronunciation of Dione and Tethys are not those given by present-day dictionaries in which all the vowels of Dione and the "e" of Tethys are long. One might question the fitness of Enceladus and, to a lesser extent, of Titan.

These lines, written in 1858, are now in some respects obsolete. The defense of Marius has been cited. If Sir John could name eight satellites, none of which he discovered, it does not seem inappropriate to accept the names proposed by Marius, who, at least, shared in the discovery of these satellites. Otherwise we should, perhaps, in fairness, not use the term Galilean satellites, use of which likewise shows a preference. The names Io, etc., are now used to some extent in the *British Nautical Almanac*, and, as already shown, there is now inconsistency, if not confusion, in the designation of Jupiter's satellites by numbers. Should the Marius taboo be kept alive? Should great weight be given Barnard's comments in the light of present altered situation?

Sir John Herschel discards a number system in respect to Saturn's satellites. Others do not wholly. The almanacs number them in order of increasing distance from Saturn, although they make full use of the mythological names. Russell, Dugan, and Stewart, in their "Astronomy," number them, and in the revised edition the satellites of Uranus also, in order of discovery. Any other system, may, of course, be upset by the discovery of additional satellites.

A ninth satellite of Saturn was discovered in 1898. Since this satellite is more distant than the others, its discovery introduced no confusion in numbering. The story of its name is told in the following passage:¹⁷

"Prof. William H. Pickering, as the discoverer, suggests that the name Phoebe, a sister of Saturn, be given to the new satellite. Three of the satellites, Tethys, Dione, and Rhea, have already been named for Saturn's sisters, and two, Hyperion and Japetus, for his brothers."

Professor Pickering thought that he had discovered a tenth satellite, in 1905, about which he writes as to its name:¹⁸ "A name has been selected from among those of the sisters of Saturn, as in the case of Phoebe, and it has been decided to call the new satellite Themis." This supposed satellite has not been followed by continued observations and its existence is doubted. It is usually not listed among the satellites. It was found to be seventh in order of distance from the planet, and, if

accepted, it would alter the numbers of the outer satellites. Two of the satellites of Uranus were discovered by Sir Wm. Herschel in 1787. He thought that he had detected several others. In accordance with precedent he assigned them numbers, not names. In 1851, Lassell discovered two additional satellites and showed that only two of Herschel's satellites were real. Confusion was thus created.¹⁹ Lassell avoided the difficulty by naming the satellites. In his words:²⁰ "In these tables I have for facility of reference employed a nomenclature of the satellites of Uranus proposed at my request by Sir John Herschel and selected by him from fairy mythology. The most distant of the two bright satellites discovered in 1787 by Sir W. Herschel is denominated Oberon, the other Titania, and, pursuing still the order of distance, the inner ones now discovered are Umbriel and Ariel."

Further information is given by Sir John, himself, who wrote:²¹ "Proceeding from without, inward in succession, the names Oberon, Titania, Umbriel, and Ariel, of the fairies, sylphs, and gnomes of Shakespeare and Pope have been assigned respectively."

Oberon and Titania are the king and queen of fairies in Shakespeare's "A Midsummer Night's Dream." Umbriel is a gnome and Ariel a sylph in Pope's "Rape of the Lock." Ariel is also a male spirit in Shakespeare's "Tempest." The name is also that of a rebel angel in Milton's "Paradise Lost." These satellites are not numbered in the almanacs.

Thus the discoverer, Sir Wm. Herschel, was represented by his son in the naming. There is here the only departure from classical mythology (excepting the Moon), which is a bit strange in view of Sir John's comment in connection with the names of the satellites of Saturn. Sir John, although he discovered no satellites, provided the names for twelve, that is, for all known in his day, excepting the Moon and the four of Jupiter whose names he rejects. The Moon, Deimos, Phobos, and Phoebe are in fact the only satellite names in normal use today not

NAMES AND PRONUNCIATIONS*

Ariel	â'ri-ĕl	Io	ī'ō	Rhea	re'ā
Callisto	kā-līs'tō	Japetus	jăp'ĕ-tŭs	Tethys	tĕ'thĭs
Deimos	dī'mōs	Mimas	mī'mās	Themis	thē'mīs
Dione	dī-ō'nē	Moon	mōon	Titan	tī'tān
Enceladus	ĕn-sĕl'ā-dŭs	Oberon	ō'bĕr-ŏn	Titania	tī-tā'nī-ā
Europa	ū-rō'pā	Phobos	fō'bōs	Triton	trī'tŏn
Ganymede	gān'ī-mēd	Phoebe	fē'bē	Umbriel	ŭm'brī-ĕl
Hyperion	hī-pĕr'ī-ŏn				

* For key to pronunciation see Pop. Astr. 50:357